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June 18, 1996

Mr. Ken Johnson
12 CES/CEV
1651 5th Street West
Randolph AFB, Texas 78150-4513

Subject: Extended Bioventing Testing Results at the Aboveground Jet Fuel Storage Tank #20, Randolph AFB LPST # 104626 (Contract No. F41624-92-8036, Order 17)

Dear Mr. Johnson:

Parsons Engineering Science, Inc. (Parsons ES) is pleased to submit the results of the extended bioventing testing at the aboveground jet fuel storage Tank #20 at Randolph Air Force Base (AFB), located in San Antonio, Texas. Soil gas samples were collected and *in situ* respiration testing was performed by Parsons ES from 3 to 8 May 1996 to assess the extent of remediation completed during approximately three years of air injection bioventing. The purpose of this letter is to summarize site and bioventing activities to date, present the results of the most recent respiration and soil gas sampling, and make recommendations based on site data. A site layout and three tables are attached. The as-built bioventing system and sampling/respiration testing locations are illustrated on Figure 1. Table 1 summarizes soil analytical results as compared to State of Texas criteria. Tables 2 and 3 provide results of initial, 1-year, and 3-year soil gas sampling, and respiration testing, respectively.

## SITE/PROJECT HISTORY

Tank #20 is a 42,000 gallon tank measuring 32 feet high by 50 feet in diameter. In the past, aviation gasoline (AVGAS), and JP-4 jet fuel were stored in the tank. Currently, Tank #20 is used to store JP-8 jet fuel. It is suspected that contamination of the soil occurred during periodic draining of water condensation from the tank. Condensate was drained from the tank and released directly onto the ground surface by opening a drain on the south side of the tank. During draining activities, the drain remained open until fuel product was observed in the flow. Product was not separated from condensate, and as a result, product was released to the ground each time the tank was drained. Randolph AFB now utilizes an oil/water separator to prevent product releases during condensate draining activities.

In August 1992, Extra Engineers, Inc. (EEI) performed a site assessment and a vapor extraction pilot study for the Tank #20 area. Soil samples from nine soil borings were collected and analyzed for total petroleum hydrocarbons (TPH) and benzene,



AQM01-03-0426

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toluene, ethylbenzene, and total xylenes (BTEX). Locations for soil borings B5 through B9 are shown on the site layout (Figure 1). Soil borings B1 through B4 were located within 45 to 60 feet of the tank, but are not shown on Figure 1.

In March 1993, a pilot scale bioventing system was installed in the Tank #20 area by Parsons ES [formerly Engineering-Science (ES), Inc.] as part of the Air Force Center for Environmental Excellence (AFCEE) Bioventing Pilot Test Initiative (Contract No. F33615-90-D-4014, Order 14). As shown in Figure 1, the installed bioventing system consisted of three vent wells (VWs), three vapor monitoring points (MPs), one background well, and a blower unit. During installation, respiration and air permeability testing and soil and soil gas sampling also were performed. A detailed description of bioventing system design and initial site activities are provided in the May 1993 Interim Pilot Test Results report prepared by ES for this site. The project at Tank #20 included 1 year of system operation followed by soil gas sampling and respiration testing.

Following system installation and prior to 1-year testing, Randolph AFB upgraded the secondary containment for Tank #20. As part of the upgrade, a high density polyethylene (HDPE) liner was placed within the secondary containment berm and a 20 foot concrete apron was placed around the tank. Placement of the liner and concrete apron covered the well boxes for VW1 and VW3, making these points inaccessible; however, each of these VWs remained operable. VW2 and the MPs, while located within the area covered by the liner and apron, remained accessible for 1-year testing activities since their well boxes were not covered during upgrade of the containment system.

Soil gas samples were collected and *in situ* respiration testing was performed in May 1994 following 1 year of system operation. The system was shut down 30 days prior to testing to allow soils and soil gas to come to equilibrium in order to compare 1-year and initial conditions. Soil samples were not collected at the 1-year testing period as this would have required penetration of the secondary containment liner. Results of the 1-year bioventing test at Tank #20 were summarized in a 5 May 1995 memorandum from AFCEE to Randolph AFB.

From May 1994 to March 1995 Randolph AFB was responsible for bioventing system operation at Tank #20. System operation was not continuous during this period and the duration and dates of system operation are not known.

On 31 March 1995, the Tank #20 site was added to the Extended Bioventing Program (Contract No. F41624-92-D-8036, Order 17) awarded by AFCEE to Parsons ES. Under the extended program, the Tank #20 site was allocated funding for an additional year of system operation and testing (Option 1) and for site closure (Option 2), if the results of the additional year of testing demonstrate adequate site remediation.

System operation began again on 31 March 1995 and continued to early April 1996. Soil gas sampling and respiration testing, performed in early May 1996, were

conducted following one month of system shutdown to allow equilibrium conditions to develop in site soils and allow comparison to initial and 1-year results.

## EXISTING SOIL DATA AND STATE OF TEXAS CRITERIA

No soil sampling has been performed at the Tank #20 site since installation of the pilot scale bioventing system in March 1993. As previously mentioned, 1-year soil samples could not be collected at the Tank #20 site due to the placement of a HDPE liner over the site for secondary containment. In addition, soil sampling was not included as part of the Option 1 testing activities under the extended program. However, based on soil data collected from the site in 1992 and 1993, it appears that hydrocarbon contamination levels in site soils were close to meeting State of Texas risk-based criteria prior to installation of the pilot-scale bioventing system. Table 1 provides a summary of soil analytical results obtained during sampling by EEI and ES in August 1992 and March 1993, respectively, and compares these results to the Texas Natural Resource Conservation Commission's (TNRCC) risk-based assessment protocols.

The TNRCC Plan A criteria depicted in Table 1 represent maximum BTEX soil concentration values for Beneficial Groundwater Use Category I, the most stringent groundwater protective category for the State. As evident from the soil sample results provided, soils in the vicinity of Tank #20 met, or nearly met, all Plan A criteria, prior to bioventing system startup, with the possible exception of benzene. Based on the following soil gas chemistry and respiration testing results, site soils have been substantially remediated as a result of approximately three years of bioventing system operation and are likely to meet all Plan A criteria.

## SOIL GAS CHEMISTRY RESULTS

Field screening and collection of soil gas samples for laboratory analysis were performed on 3 May 1996 following one month of system shutdown. Soil gas samples were collected from each MP, except MPC-3, and field-screened to assess soil gas concentrations of oxygen, carbon dioxide, and total volatile hydrocarbons (TVH). As can be seen from the results presented in Table 2, static oxygen concentrations in soil gas have increased with continued bioventing at the site. Substantial increases in soil gas oxygen occurred at both MPA intervals between the 1-year and 3-year testing events. These increases in soil gas oxygen concentrations indicate that aerobic hydrocarbon biodegradation rates have decreased substantially, suggesting that very little substrate (fuel hydrocarbons) remain in the soil at these locations. More modest increases in oxygen concentration have occurred at MPB-3 and MPC-3. Soils at the 6-foot depths of MPB and MPC have experienced little increase in soil gas oxygen concentration and as a result appear to have ongoing aerobic activity. The amount of aerobic activity and associated hydrocarbon contamination at these points appears to be slight however, as TVH soil gas concentrations measured in the field at MPB-6, MPC-6, and all other MPs indicate a consistent 2 order of magnitude reduction from initial

measurements. Soil gas analytical data collected 1 year and 3 years after system installation further indicate substantial reductions in soil hydrocarbon contamination.

Initial, 1-year, and 3-year soil gas samples for laboratory analysis were collected at MPA-6 and MPC-6. In addition, 3-year soil gas samples for laboratory analysis also were collected at MPB-6 and MPC-3 (Table 2). For all three sampling events, samples were sent to Air Toxics, Ltd. laboratory in Folsom, California and analyzed for TVH, and BTEX using EPA Method TO-3. As can be seen from the results at MPA-6 and MPC-6, BTEX concentrations in soil gas were reduced to non-detect, or near non-detect, levels during the first year of system operation. BTEX concentrations generally were further reduced as a result of bioventing performed under the extended program. TVH concentrations were reduced three orders of magnitude during the first year of system operation and reduced an additional order of magnitude as a result of extended bioventing. Field and analytical soil gas results strongly suggest nearly complete remediation of hydrocarbon contaminants at the Tank #20 site.

## RESPIRATION TEST RESULTS

A three-year *in situ* respiration test was performed at the Tank #20 site from 4 to 8 May 1996. The test was performed according to procedures outlined in the May 1993 Interim Test Results report and followed one month of bioventing system shutdown. Air was injected for 22 hours into five MPs (MPA-3, MPA-6, MPB-3, MPB-6, and MPC-6), using 1 cubic-foot-per-minute (cfm) pumps, to oxygenate site soils. Following air injection, changes in oxygen, carbon dioxide, and TVH soil gas concentrations were monitored over a 72-hour period. Observed rates of oxygen utilization were then used to estimate aerobic fuel biodegradation rates at Tank #20. Table 3 summarizes initial, 1-year, and 3-year respiration and fuel biodegradation rates at the site.

Observed oxygen utilization rates have decreased significantly as a result of bioventing system operation at Tank #20. As can be seen from the results shown in Table 3, significant reductions occurred in respiration and biodegradation rates following the first year of system operation. Respiration rates at the site have been further reduced with extended system operation (Option 1) measuring only 12 to 25 percent of the 1-year values. Estimated fuel biodegradation rates have also decreased with extended system operation. Oxygen utilization and fuel biodegradation rates typically decrease with continued bioventing as the lighter, more readily biodegraded hydrocarbons are preferentially destroyed over more biologically recalcitrant, higher molecular weight hydrocarbons. The BTEX compounds, as demonstrated by the soil gas results have been almost completely biodegraded.

## RECOMMENDATIONS

Based on initial soil sampling results and soil gas and respiration results obtained following initial and extended bioventing system operation, it is recommended that site closure (Option 2) activities be initiated for the Tank #20 site. Parsons ES

recommends pursuing closure of the site based on existing data, and as a first deliverable, under Option 2, proposes to complete a Plan A Assessment as required by the TNRCC. The Plan A Assessment report provides the framework for a standardized evaluation of site risks. A proposed action for the site, based on the assessment, is provided under Attachment 20 of the report. Following AFCEE review, the assessment report would be forwarded to the TNRCC for decision.

If the TNRCC agrees with site closure based on existing data, AFCEE funding allocated for site closure could possibly be used for system abandonment. If the TNRCC recommends collection of additional data to further demonstrate site compliance with Plan A criteria, a closure sampling and analysis plan (CSP) would be developed and site sampling would be performed. Based on the existence of the HDPE liner at the site, soil sampling in the immediate vicinity of Tank #20 would be discouraged as this would require penetration of the liner and a possible loss in liner integrity. As an alternative, soil gas sampling could be performed within the area covered by the liner, and soil sampling performed at the liner's periphery. The CSP, if required, would outline TNRCC soil and soil gas sampling requirements necessary for site closure. While Parsons ES believes adequate remediation of the Tank #20 site has occurred for closure based on existing data, air injection at the site should be continued until site closure is approved by the TNRCC.

If you have any questions or require additional information, please contact either Brian Vanderglas at 512/719-6000 or John Ratz at 303/831-8100.

Sincerely,

PARSONS ENGINEERING SCIENCE, INC

Brian Vanderglas

Brian Vanderglas, C.P.S.S.
Site Manager, CAPM00758

John Ratz

John W. Ratz, P.E.
Project Manager

cc: Capt Ed Marchand, AFCEE
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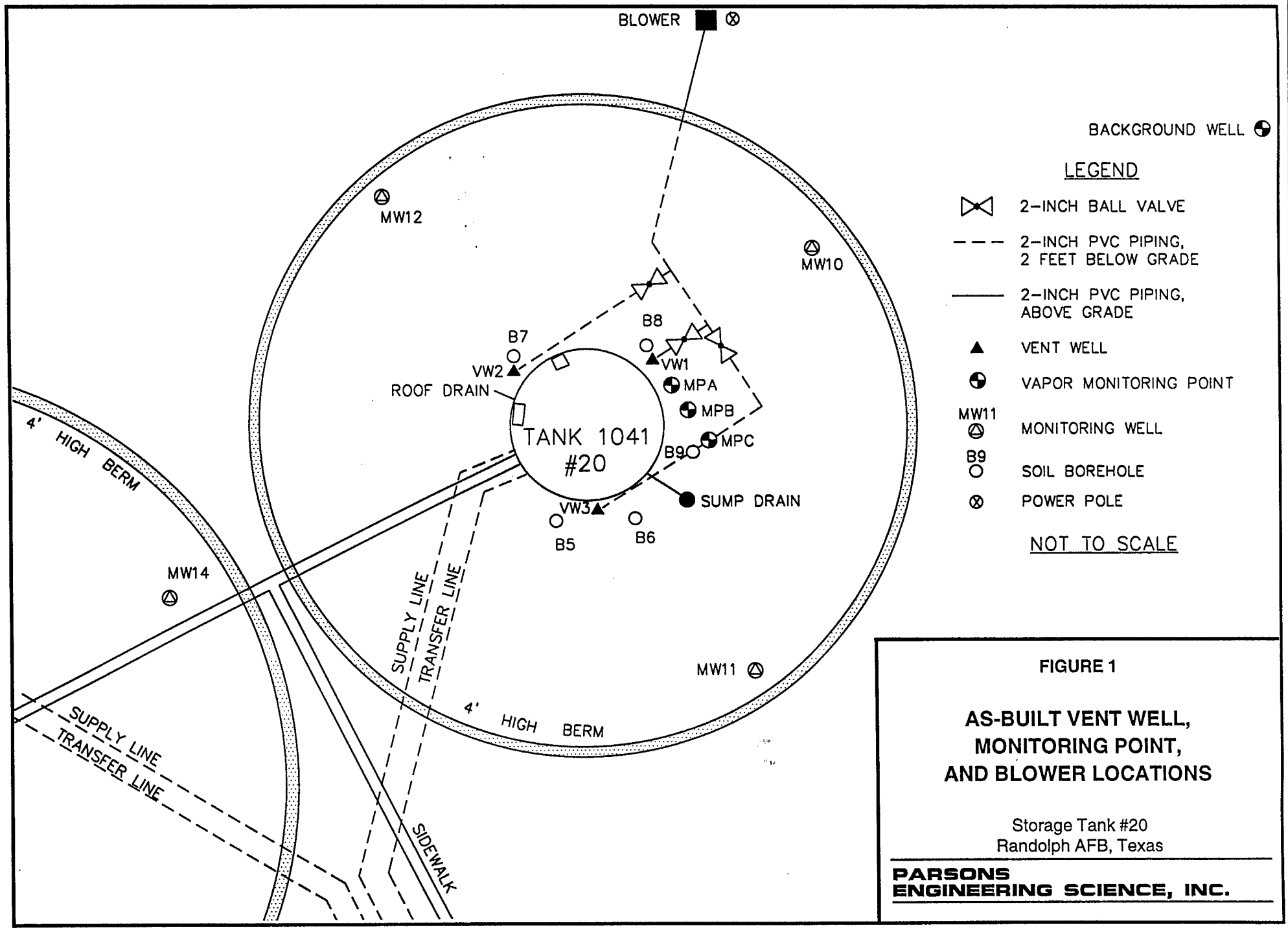


**FIGURE 1**

**AS-BUILT VENT WELL, MONITORING POINT, AND BLOWER LOCATIONS**

Storage Tank #20
Randolph AFB, Texas

**PARSONS ENGINEERING SCIENCE, INC.**

# Table 1
## Soil Analytical Results Compared to TNRCC Plan A Criteria
## Aboveground Jet Fuel Storage Tank #20 (LPST #104626)
## Randolph AFB, Texas

| | Analyte[a] | | | | |
|---|---|---|---|---|---|
| | TPH (mg/kg)[b] | Benzene (mg/kg) | Toluene (mg/kg) | Ethylbenzene (mg/kg) | Xylenes (mg/kg) |
| **Plan A Criteria[c]** | NA[d] | 0.13 | 69 | 160 | 568 |
| **Sample Location[e]** | | | | | |
| **Parsons ES[f]** | | | | | |
| VW1-5 | 32 | 0.31U[g] | 1.5 | 0.26U | 1.4 |
| MPA-1 | 852 | 1.3U | 16 | 13 | 130 |
| MPA-9.5 | 3.2 | 0.0014 | 0.0031 | 0.0012U | 0.0022U |
| MPB-5 | 17 | 0.14U | 1.2 | 0.12U | 2.0 |
| **EEI[h]** | | | | | |
| B1-9 | 190 | 0.4U | 0.4 | 0.8 | 6.5 |
| B1-13 | 45 | ---[i] | --- | --- | --- |
| B2-3 | 10U | --- | --- | --- | --- |
| B2-12.5 | 10U | --- | --- | --- | --- |
| B3-12 | 10U | --- | --- | --- | --- |
| B3-12.5 | 25 | --- | --- | --- | --- |
| B4-9 | 72 | --- | --- | --- | --- |
| B4-14.5 | 24 | --- | --- | --- | --- |
| B5-3 | 24 | --- | --- | --- | --- |
| B6-3 | 800 | 0.4U | 0.4U | 0.4U | 0.4U |
| B7-3 | 360 | --- | --- | --- | --- |
| B8-2 | 1,100 | --- | --- | --- | --- |
| B9-1.5 | 190 | --- | --- | --- | --- |

[a] TPH=total petroleum hydrocarbons analyzed by EPA Method 418.1; BTEX analyzed by EPA Method SW8020.

[b] mg/kg=milligrams per kilogram.

[c] Represents the most stringent groundwater protective category (Beneficial Groundwater Use Category I).

[d] NA=not applicable; Plan A does not provide a TPH criterion.

[e] Sample location gives location of boring and sample depth in feet below ground surface.

[f] Soil samples collected March 19-20, 1993, by Parsons ES, prior to bioventing system startup. 1-year soil samples were not collected due to a li being placed over the site.

[g] U=compound analyzed for, but not detected. Number shown represents the method detection limit.

[h] Soil samples collected on August 27-28, 1992, by EEI.

[i] ---=not analyzed.

## Table 2
## Initial, 1-Year and 3-Year Soil Gas Field and Laboratory Analytical Results
## Aboveground Jet Fuel Storage Tank #20 (LPST #104626)
## Randolph AFB, Texas

| | | Field Screening Data | | | Analytical Data | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sample Location[a/] | Sampling Event[b/] | Oxygen (percent) | Carbon Dioxide (percent) | Field TVH[c/] (ppmv)[d/] | Laboratory TVH (ppmv) | Benzene (ppmv) | Toluene (ppmv) | Ethylbenzene (ppmv) | Xylenes (ppmv) |
| MPA-3 | Initial | 1.7 | 8.8 | >20,000 | ---[e/] | --- | --- | --- | --- |
| | 1-Year | 1.0 | --- | 120 | --- | --- | --- | --- | --- |
| | 3-Year | 11.0 | 5.0 | 296 | --- | --- | --- | --- | --- |
| MPA-6 | Initial | 0.8 | 9.3 | >20,000 | 21,000 | 21 | 1.0U[f/] | 5.5 | 16 |
| | 1-Year | 1.8 | --- | 59 | 53 | 0.002U | 0.002U | 0.002U | 0.063U |
| | 3-Year | 12.0 | 7.5 | 180 | 1.1 | 0.002U | 0.004 | 0.002U | 0.013 |
| MPB-3 | Initial | 5.7 | 7.1 | >20,000 | --- | --- | --- | --- | --- |
| | 1-Year | 1.0 | --- | 77 | --- | --- | --- | --- | --- |
| | 3-Year | 8.0 | 0.05 | 220 | --- | --- | --- | --- | --- |
| MPB-6 | Initial | 0.5 | 9.1 | >20,000 | --- | --- | --- | --- | --- |
| | 1-Year | 1.9 | --- | 68 | --- | --- | --- | --- | --- |
| | 3-Year | 3.0 | 5.0 | 175 | 1.7 | 0.002U | 0.002U | 0.002U | 0.003 |
| MPC-3 | Initial | 2.2 | 8.4 | >20,000 | --- | --- | --- | --- | --- |
| | 1-Year | 7.0 | --- | 240 | --- | --- | --- | --- | --- |
| | 3-Year | --- | --- | --- | 3.8 | 0.005 | 0.017 | 0.004 | 0.024 |
| MPC-6 | Initial | 0.0 | 10.5 | >20,000 | 22,000 | 16 | 1.1U | 4.9 | 21 |
| | 1-Year | 7.0 | --- | 62 | 47 | 0.002U | 0.002U | 0.094 | 0.38 |
| | 3-Year | 0.0 | 2.0 | 300 | 3.4 | 0.014 | 0.031 | 0.002U | 0.012 |

[a/] Sample location identifies the monitoring point and depth in feet below ground surface.
[b/] Soil gas sampling performed in March 1993, May 1994, and May 1996.
[c/] TVH=total volatile hydrocarbons.
[d/] ppmv=parts per million, volume per volume.
[e/] ---=not analyzed.
[f/] U=compound analyzed for , but not detected. Number shown represents the method detection limit.

## Table 3
## Initial, 1-Year, and 3-Year Respiration and Degradation Rates
## Aboveground Jet Fuel Storage Tank #20 (LPST #104626)
## Randolph AFB, Texas

| Location-Depth | Initial (March 1993) | | 1-Year (May 1994) | | 3-Year (May 1996) | |
|---|---|---|---|---|---|---|
| | Respiration Rate (% $O_2$/min) | Degradation Rate (mg/kg/year)[a/] | Respiration Rate (% $O_2$/min) | Degradation Rate (mg/kg/year)[b/] | Respiration Rate (% $O_2$/min) | Degradation Rate (mg/kg/year)[b/] |
| VW1 | 0.0043 | 150 | NS[c/] | NC[d/] | NS | NC |
| MPA-3 | 0.0058 | 610 | NS | NC | 0.0006 | 76 |
| MPA-6 | 0.0076 | 290 | 0.0024 | 90 | 0.0006 | 28 |
| MPA-12 | NS | NC | NS | NC | NS | NC |
| MPB-3 | 0.0055 | 580 | NS | NC | 0.0007 | 88 |
| MPB-6 | 0.0084 | 320 | 0.0032 | 120 | 0.0004 | 19 |
| MPB-12 | 0.0083 | 320 | NS | NC | NS | NC |
| MPC-3 | 0.0042 | 440 | 0.0086 | 900 | 0.001 | NC |
| MPC-6 | 0.0094 | 360 | 0.0045 | 170 | 0.001 | 46 |
| VW2 | 0.0078 | 300 | NS | NC | NS | NC |

[a/] Milligrams of hydrocarbons per kilogram of soil per year.
[b/] 1-year and 3-year degradation rates based on average moisture content of the soil at initial sampling. 1-year soil sampling was not performed as a liner was placed over the site.
[c/] NS = not sampled.
[d/] NC = not calculated.